APPARATUS AND METHOD FOR MOUNTING A TIRE CONDITION SENSOR CAPSULE TO A WHEEL RIM

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention relates to tire condition sensing and more particularly to an apparatus and method for mounting a tire condition sensor capsule to a wheel rim.

2. Description of Related Art

The use of tire condition sensors is becoming increasingly popular. Some countries are implementing requirements that certain vehicles employ such devices to improve safety. Various schemes have been developed for mounting tire condition sensors to vehicle wheels. Some mount sensors to the outside of the wheel while others mount them to the inside of the wheel (inside the tire). Mounting inside the tire is a preferable method.

Various tire condition sensors operable to be mounted inside the tire are available. These sensors may include pressure sensors, temperature sensors or the like and some include transmitter circuitry for transmitting a measured tire condition value to a remote transmitter. Each manufacturer of a tire condition sensor will package its device or devices in a package of its own design. In general, tire condition sensor units are available in a wide variety of shapes and sizes to accommodate the circuitry they employ. However, some packaging can be susceptible to damage, especially during tire installation. In general, sensor packages that have protruding objects or sharp corners can be susceptible to catching on a tire as the tire is installed.

In addition each wheel rim on which a tire condition sensor might be installed has its own special requirements in relation to permissible weight of the sensor, profile, and ease of installation. Typically, this has been dealt with by providing separately packaged condition sensors for each type of wheel rim.

With the risk of damage to the sensor during tire installation, or removal, if a sensor is damaged during either of these procedures, an entirely new sensor must be installed. Damage to the sensor usually involves damage to the mounting components such as tabs or other structure on the sensor unit itself, requiring replacement of the entire sensor, even if only the sensor case, for example is broken.

What would be desirable is a way of mounting tire condition sensors in a manner that protects the sensor unit while at the same time permitting easy and inexpensive installation and removal, without requiring a brand new sensor unit when only mounting components are damaged. The present invention addresses this need.

SUMMARY OF THE INVENTION

The present invention addresses the above needs by providing an apparatus and method for mounting a tire condition sensor capsule to a wheel rim.

In accordance with one aspect of the invention there is provided an apparatus for mounting a tire condition sensor capsule to a wheel rim. The apparatus may include a housing having a receptacle having a shape complementary to the capsule to receive the capsule snugly therein. Additionally the apparatus may include a lock on the housing, cooperating with a surface on the capsule to lock the housing to the capsule, and a connector for connecting the housing to the wheel rim such that the capsule is between a portion of the wheel rim and the receptacle.

The housing may include a wall and may be rigid and/or may be formed of injection molded plastic.

The lock may be on the wall of the housing. The wall may have first and second spaced apart side portions between which the capsule is received and the lock may be on one of the first and second side portions. The lock may

include first and second clips on the first and second side portions, respectively.

The first and second side portions may have first and second edge extremities, respectively, and the lock may include first and second clips on the first and second edge extremities, respectively, which cooperate with the capsule to lock the housing to the capsule. The lock may further include third and fourth clips spaced apart from the first and second clips respectively, on the first and second edge extremities. The first and second edge extremities may have first and second contact surfaces respectively for contacting the wheel rim and the contact surfaces may have a concave shape complementary to the shape of the wheel rim.

The wall may have a weight reducing void therein and may have first and second spaced apart side portions between which the capsule is received and the wall may have an intermediate portion extending between the first and second side portions. The intermediate portion may have a weight reducing void therein and may have first and second spaced apart weight reducing voids therein.

The wall may include first and second opposite end portions extending from the intermediate portion, the capsule being received between the first and second side portions and the first and second opposite end portions. The first and second wall portions may be wider than the first and second opposite end portions such that the first and second end side portions completely cover respective side portions of the capsule and such that the first and second opposite end portions only partially cover respective end portions of the capsule.

The connector may include first and second fastener receivers on the first and second opposite end portions of the housing. The first and second fastener receivers may be molded into the housing, for example. Alternatively, the

connector may include a valve stem connector operable to cooperate with a valve stem of the wheel to secure the housing to the wheel rim. The valve stem connector may include a valve stem receptacle in the housing for receiving a portion of the valve stem, and may further include an opening in the housing, in communication with the valve stem receptacle, for receiving a fastener operable to fasten the valve stem in the valve stem receptacle.

Alternatively, the connector may include a strap holder operable to cooperate with a strap that extends around the wheel to secure the housing to the wheel. The strap holder may be formed in the housing and may include first and second slots formed in the housing, the slots being operable to receive the strap. The wall may have first and second opposite end portions and the strap holder may include first and second openings in the first and second end portions respectively, for receiving the strap.

In accordance with another aspect of the invention there is provided a method for mounting a tire condition sensor capsule to a wheel rim. The method may include receiving the capsule in a housing having a receptacle having a shape complementary to the capsule, locking the capsule in the housing, and connecting the housing to the wheel rim such that the capsule is between a portion of the wheel rim and the receptacle.

Receiving may include receiving the capsule between first and second side portions and between first and second end portions of a wall of the housing.

Locking may include engaging a clip on the housing with a surface on the capsule.

Connecting the housing to the wheel rim may include fastening first and second end portions of the housing to corresponding mounting surfaces on the wheel rim. Connecting the housing to the wheel rim may alternatively include receiving a portion of a valve stem of the wheel rim in a receptacle in

the housing and fastening the portion of a valve stem of the wheel rim in the receptacle in the housing.

Alternatively, connecting the housing to the wheel rim may involve engaging a strap extending around the wheel rim with openings in the housing.

In accordance with yet another aspect of the invention there is provided an apparatus for mounting a tire condition sensor capsule to a wheel rim. The apparatus may include a device for holding and protecting the capsule, a device for locking the capsule in the device for holding and protecting, and a device for connecting the device for holding and protecting to the wheel rim such that the capsule is between the device for holding and protecting and the wheel rim.

The device for holding and protecting may include a receptacle for receiving the capsule.

The device for locking may include a clip on the device for holding and protecting, the clip being operable to engage a surface of the capsule.

The device for connecting may include first and second fastener receivers on the device for holding and protecting.

Alternatively, the connecting device may include a valve stem connector operable to cooperate with a valve stem of the wheel to secure the device for holding and protecting to the wheel rim.

Alternatively, the connecting device may include a strap holder operable to cooperate with a strap that extends around the wheel to secure the device for holding and protecting to the wheel rim.

The device for holding and protecting may include a housing having a receptacle for receiving the capsule.

In accordance with another aspect of the invention there is provided a tire condition sensing system operable to be mounted to a wheel rim. The system may include a tire condition sensor capsule containing an electronic circuit for measuring a tire condition and for transmitting a signal indicative of the condition to a remote receiver. The system may further include a housing having a receptacle having a shape complementary to the capsule to receive the capsule snugly therein, a lock on the housing, cooperating with a cover of the capsule to lock the housing to the capsule, and a connector for connecting the housing to the wheel rim such that the capsule is between a portion of the wheel rim and the receptacle.

In accordance with yet another aspect of the invention there is provided a tire condition sensing system. The system may include a wheel rim, a tire condition sensor capsule containing an electronic circuit for measuring a tire condition and for transmitting a signal indicative of the condition to a remote receiver, a housing having a receptacle having a shape complementary to the capsule to receive the capsule snugly therein, a lock on the housing, cooperating with a cover of the capsule to lock the housing to the capsule, and a connector for connecting the housing to the wheel rim such that the capsule is between a portion of the wheel rim and the receptacle.

In accordance with another aspect of the invention there is provided a method of enabling measurement of a tire condition. The method may include installing on a vehicle a wheel to which is secured a housing having a receptacle in which a tire condition sensor capsule containing a tire condition sensor and signal transmitter is removably locked by a locking mechanism engaged with the capsule.

The present invention provides a versatile apparatus for mounting a tire condition sensor capsule to a wheel rim. As the capsule entirely encapsulates sensor and transmitter circuitry, the capsule may be treated as a separate, modular, replaceable unit. By using a housing to secure the tire condition sensor capsule to the wheel rim, expensive capsules can be replaced more easily without damage, enabling them to be removed, repaired and re-installed if desired. An inventory of various inexpensive housings may be made available to provide for mounting the same type of capsules in various ways, such as the ways described herein. An inventory of a plurality of different capsule shapes, sizes and configurations need not be maintained.

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings which illustrate embodiments of the invention,

Figure **1** is a fragmented perspective view of a wheel rim to which an apparatus according to a first embodiment of the invention is connected;

Figure **2** is a bottom perspective view of the apparatus shown in Figure **1**;

Figure **3** is a top perspective view of the apparatus shown in Figure **1**;

Figure **4** is a cross sectional view of the apparatus taken along lines **4-4** in Figure **3**;

Figure **5** is a fragmented perspective view of a wheel rim on which an apparatus according to a second embodiment of the invention is connected;

Figure **6** is a bottom perspective view of the apparatus shown in Figure **5**;

Figure **7** is a top perspective view of the apparatus shown in Figure **5**;

Figure **8** is a fragmented perspective view of a wheel rim on which an apparatus according to a third embodiment of the invention is connected;

Figure **9** is a top, perspective view of the apparatus shown in Figure **8**;

Figure **10** is a fragmented section/perspective view of the wheel rim and apparatus shown in Figure **8**; and

Figure **11** is a bottom, perspective view of the apparatus shown in Figure **8**.

DETAILED DESCRIPTION

Referring to Figure **1**, an apparatus for mounting a tire condition sensor capsule **10** to a wheel rim **12** is shown generally at **14**. The apparatus **14** comprises a housing **16** having a receptacle complementary to the sensor capsule **10** to receive the sensor capsule therein. Referring to Figure **2**, a lock, shown generally at **22** is provided on the housing **16** to cooperate with a cover **24** of the sensor capsule **10** to lock the housing to the sensor capsule. Referring to Figures **1** and **2** a connector **26** is also provided on the housing **16** for connecting the housing to the wheel rim **12** such that the sensor capsule **10** is between a portion of the wheel rim and the receptacle.

The tire condition sensor capsule **10** may be of the type that houses electronic circuits including a sensor circuit and transmitter circuit, for example, for measuring and transmitting a signal indicative of air pressure and/or temperature inside the space formed between the wheel rim **12** and a tire (not shown) fitted to the wheel rim. Such sensor capsules **10** can be made in mass quantities and may have a modular shape for interchangeability. The modular shape permits all electronics and sensors to be located within the sensor capsule so there are no extraneous protrusions or projections that may be susceptible to damage during tire installation, for example.

Referring to Figures **2** and **3**, in this embodiment the housing **16** is formed by injection molding of plastic to form a relatively rigid structure having a relatively thin sheet-like wall **28** formed to have first and second spaced apart

opposite side portions **30** and **32** and first and second opposite spaced apart end portions **34** and **36** connected together by an intermediate portion **38**. These portions of the wall **28** define the receptacle in which the sensor capsule **10** is received as seen best in Figure **2**. The sensor capsule **10** is thus received between the first and second spaced apart opposite side portions **30** and **32** and the first and second opposite spaced apart end portions **34** and **36** of the wall **28**.

In this embodiment, the first and second side portions **30** and **32** have generally the same width and thus extend away from the intermediate portion **38** by approximately the same distance. The first and second side portions **30** and **32** have first and second edge extremities **40** and **42** respectively which are terminated in first and second parallel contact surfaces **44** and **46** respectively, for contacting the wheel rim **12** when the housing **16** is installed as shown in Figure **1**. In this embodiment, the first and second contact surfaces **44** and **46** are concaved to have a shape complementary to the portion of the wheel rim **12** on which the housing **16** and sensor capsule **10** will be installed. The housing **16** may be installed on a drop center of the wheel rim **12**, for example, away from tire mounting flanges so as not to interfere with tire mounting operations. Depending on the diameter of the wheel rim **12** on which the housing **16** will be installed, an arc of the first and second contact surfaces **44** and **46** may have a radius of between about **6** inches to about **36** inches, for example. For a **17** inch wheel rim, the contact surfaces may have a radius of about **7** inches, for example.

Referring to Figure **3**, in this embodiment, the housing **16** is formed to have a relatively smooth contour with no protruding projections or sharp corners that may come into contact with the tire during installation. Also, for weight reduction, the housing **16** has a weight reducing void therein and in the embodiment shown the weight reducing void includes first and second spaced apart weight reducing voids **50** and **52** in the intermediate portion **38**. These weight reducing voids **50** and **52** are simply areas in the wall **28** that are open.

This reduces the weight of the housing **16**, thus reducing its effect on the balance of the wheel rim **12**.

Referring to Figure **4**, the lock **22** on the housing is shown in greater detail. Desirably, the lock is on the wall **28** and more desirably on at least one of the first and second side portions **30** and **32** and more desirably, both. Referring to Figure **2**, in this embodiment, the lock includes first, second, third and fourth clips **60**, **62**, **64** and **66**. The first and third clips **60** and **64** are formed at the edge extremity **40** of the first side portion **30** and the second and fourth clips **62** and **66** are formed at the edge extremity **42** of the second side portion **32**. Referring to Figures **2** and **4**, the clips **60**, **62**, **64** and **66** are operable to cooperate and engage with a bottom edge and bottom planar surface of the sensor capsule **10** to lock the housing **16** to the sensor capsule.

In the embodiment shown in Figures **1-4**, the connector **26** for connecting the housing **16** to the wheel rim **12**, includes first and second mounting flanges **65** and **67** formed in the first and second end portions **34** and **36** of the housing respectively. This type of connector **26** is for use in conjunction with mounting seats **70** and **72** already installed or formed on the wheel rim **12**. In this embodiment, the mounting seats **70** and **72** include first and second bent metal tabs **74** and **76** having portions that act as the mounting seats and wheel rim mounting portions, one of which is exemplified by item **78**, which are mounted to the wheel rim **12**. These wheel rim mounting portions (**78**) may be mounted to the wheel rim **12** by bonding, welding or rivets, for example. Generally, the bent metal tabs **74** and **76** are mounted in spaced apart relation along the drop center of the wheel rim **12** at a spacing suitable to permit alignment of the first and second mounting flanges **65** and **67** on the housing **16** with the mounting seats **70** and **72**.

In this embodiment, the first and second mounting flanges **65** and **67** generally follow the contour of the contact surfaces **44** and **46** of the first and second side portions **32** and **34** and thus follow the contour of the drop center

of the wheel rim **12**. Each mounting flange **65** and **67** has reinforcing members, two of which are shown in Figure **1** at **80** and **82** and each mounting flange has a respective fastener receiver opening **84** and **86** seen best in Figure **2**, operable to receive a fastener as shown in Figure **1**, such as a rivet or screw to secure it to its corresponding mounting seat such that the sensor capsule **10** is held between a portion of the wheel rim **12** and the receptacle.

Referring to Figures **5** and **6** an apparatus according to a second embodiment of the invention is shown generally at **100**. The apparatus **100** is similar to the apparatus **14** according to the first embodiment with the exception that the first and second end portions **34** and **36** of the wall **28** cooperate to act as a strap holder operable to cooperate with a strap **102** that extends around the wheel rim to secure the housing **16** to the wheel rim. To do this, the first and second end portions **34** and **36** are formed with first and second openings **104** and **106** respectively, which in this embodiment are horizontally oriented slots for receiving the strap **102** therethrough. The strap **102** may be a large diameter hose-type clamp, for example.

In this embodiment, to define the openings **104** and **106**, the first and second end portions **34** and **36** have respective flat wall portions, only one of which is shown at **108** in Figure **7**, that extend at an angle inwardly of an outer surface **110** of the respective end portion (in this case the first end portion **34**). A lower wall portion **112** extends upwardly from an edge extremity **114** of the end portion, following the contour of the end portion **34** and terminates in a recessed edge **116** spaced apart from a facing edge **118** of the flat wall portion **108**. The recessed edge **116** allows for easy insertion of an end of the strap **102** into the slot formed between the recessed edge **116** and the facing edge **118**, during installation.

Referring to Figure **8** an apparatus according to a third embodiment of the invention is shown generally at **130**. This apparatus is similar to the

apparatus of the first and second embodiments with the exception that the connector for connecting the housing **16** to the wheel rim **12** includes a valve stem connector **132** operable to cooperate with a valve stem **134** of the wheel rim **12** to secure the housing to the wheel rim.

Referring to Figures **9** and **10**, the valve stem connector **132** includes a valve stem receptacle **136** in the first side portion **30** of the housing **16** for receiving a portion of the valve stem **134**. In particular, the valve stem receptacle is operable to receive a butt end **138** of the valve stem **134** used to admit and release air from a tire mounted to the wheel rim **12**. Referring to Figures **9**, **10** and **11** the valve stem connector further comprises an opening **140** in the housing **16**, in communication with the valve stem receptacle **136**, for receiving a fastener **142** operable to fasten the valve stem **134** in the valve stem receptacle **136**.

A top portion of the intermediate portion **38** of the wall **28** forming the housing **16** is shaped to form a recess **144** providing access to an opening coterminous with the opening **140** into which the fastener **142** may be inserted to extend through the opening **140** and into a threaded opening **148** in the butt end **138** of the valve stem **134**. The opening **140** and recess **144** thus enable the fastener **142** to be used to secure the butt end **138** of the valve stem **134** to the housing **16**. The valve stem **134** may then be secured to the wheel rim **12**, using conventional methods, as shown in Figure **10**, whereby the housing **16** and capsule **10** held thereby is secured to the wheel rim.

Referring to Figures **8**, **9** and **11** in this embodiment, the end portions **34** and **36** are shorter than the side portions **30** and **32**, to reduce weight and material usage since these portions are not used in connecting the housing **16** to the wheel rim **12** in this embodiment.

The lock for locking the housing **16** to the capsule **10** is the same as in the previously described embodiments.

In operation of the apparatus described herein, on being presented with a wheel rim **12** of a particular type, an installer may select from a plurality of housings **16** (such as the three housing configurations shown and described herein), a housing suitable for the particular type of wheel rim on which the capsule **10** is to be installed. Referring to Figure **3**, on selecting an appropriate housing **16**, the installer may then insert the capsule **10** into the receptacle in the selected housing such that the clips **60**, **62**, **64** and **66** snap onto the under surface of the capsule, thereby locking the capsule in the receptacle to form a single unit comprised of the capsule and housing locked thereto. The capsule **10** is thus received and locked in the receptacle.

Then, the appropriate connecting arrangement for the housing **16** selected may be employed. Referring to Figure **1**, to connect a housing **16** according to the first embodiment described herein to the wheel rim **12** the installer positions the housing **16** over the mounting seats **70** and **72** to align the openings in the flanges with the mounting seats and inserts a rivet, for example and then draws the rivet tight to secure the housing to the wheel rim such that the capsule **10** is positioned between the receptacle and the wheel rim. A tire may then be installed on the wheel rim **12** and then the wheel rim may be installed on a vehicle.

Referring to Figures **5** and **6**, to connect a housing **16** according to the second embodiment described herein, after the capsule **10** is received and locked in the receptacle as described above, the installer inserts an end portion of a strap **102** through the opening **104** in the first end portion **34**, passes it under the capsule and then through the opening **106** in the second end portion **36** such that the strap is captured by the openings in the housing. The strap **102** is then wrapped around the circumference of the drop center of the wheel rim **12** and opposite ends of the strap are secured together using conventional methods. A tire may then be installed on the wheel rim **12** and then the wheel rim may be installed on a vehicle.

Referring to Figures **9** and **10**, to connect a housing **16** according to the third embodiment described herein, after the capsule **10** is inserted and locked in the receptacle as described above the installer then inserts a fastener **142** into the recess **144** to extend through the opening **140** to protrude from the valve stem receptacle **136** and then screws the fastener into the butt end **138** of the valve stem **134** until the butt end is drawn into the valve stem receptacle. Then, the valve stem **134** is inserted through an opening in the wheel rim **12** and is secured thereto using conventional securing methods. The housing **16** is thus secured to the wheel rim **12** through the valve stem **134**. A tire may then be installed on the wheel rim **12** and then the wheel rim may be installed on a vehicle.

The above described embodiments provide a versatile apparatus for mounting a tire condition sensor capsule to a wheel rim. As the tire condition sensor capsule entirely encapsulates the sensor and transmitter circuitry, the capsule may be treated as a separate, modular, replaceable unit. By using the housing described herein to secure the capsule to the wheel rim, i.e. not directly connecting the capsule to the wheel rim, expensive capsules can be replaced more easily without damage, enabling them to be removed, repaired and re-installed if desired. The housing may be damaged, even deliberately, to enable the capsule to be removed and a new inexpensive housing may used to re-install the old capsule to the wheel rim. In effect, since the capsules are modular, any housing of the type described herein may be used. Thus an inventory of various inexpensive housings may be made available to provide for mounting the same type of capsules in various ways, such as the ways described herein. An inventory of a plurality of different capsule shapes, sizes and configurations need not be maintained.

While specific embodiments of the invention have been described and illustrated, such embodiments should be considered illustrative of the

invention only and not as limiting the invention as construed in accordance with the accompanying claims.